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EPRI

Process Water Reduction Using Water Pinch Technology

The Challenge: Determine Potential Optimum Improvements

Solutia's W. G. Krummrich plant in Sauget, Ill, produces a wide variety of chemical intermediates used in the manufacture of dyes, agricultural products, pharmaceuticals, and rubber chemicals. Total freshwater intake at the plant in 1995 was on the order of 2400 gpm (0.15 m^3/s), and total wastewater flow leaving the site battery limits was approximately 2000 gpm (0.13 m^3/s).

Annual external costs were:

	Fixed	Variable	Total
City Water	0.00	1.41	1.41
P-Chem	1.68	0.68	2.36
American Bottoms	4.70	0.00	4.70
Totals ($MM/yr)	6.38	2.09	8.47

The contracts with both Publicly Owned Treatment Works (POTW) (P-Chem and American Bottoms) were due for renegotiation, with the possibility of a significantly different tariff structure, thereby creating incentives for flow reduction. Solutia needed to know what sort of flow and contaminant reduction was possible, and at what cost, in order to determine the optimum level of on-site pretreatment and to formulate an appropriate negotiating strategy.

The Old Way

Most companies in this situation would have taken one of two typical approaches:

- Gone along with whatever tariff structure was proposed, however grudgingly
- Attempted to cut a favorable deal for themselves at the expense of other ratepayers, relying on rules of thumb and guesswork to assess the cost impact on their own facility

The New Way

Solutia elected not to follow the adversarial road. Instead, the company decided to find out what was the true water conservation potential at their site, and what would be the capital as well as operating costs of achieving various levels of flow and contaminant concentration reduction. They hired a consulting firm to conduct a comprehensive water study with the following objectives:

Establish the water consumption and wastewater flow targets, using the Water Pinch approach.

- Identify practical wastewater re-use projects to minimize consumption and effluent flow.
- Identify beneficial process modifications to reduce contaminant load.
- Define the projects in sufficient detail to enable Solutia to develop reasonably accurate capital cost estimates.

The consultant's study provided a road map for phased implementation of water conservation and wastewater minimization projects, including economics.

Armed with this information, Solutia was able to negotiate a fair and equitable agreement with the POTW representatives that was acceptable to all parties. It involved a coordinated technical revamp of the Solutia and POTW facilities so as to minimize wastewater treatment costs for the combined system.

The Water Pinch Methodology

For any water-related process, it is possible to construct a composite profile of water demand (sinks) and wastewater effluents (sources). Figure 1 graphically depicts the water sources and sinks for a typical process, on purity vs. flow axes. This identifies the pinch, the point in the process that limits the potential for water conservation. The area of overlap (shaded) shows the scope for water reuse. As with Energy Pinch, rigorous design rules must be followed to evolve the optimum design.

Although the targeting concept is simple, optimizing a water network involving a combination of reuse, recycling, and treatment options can become complex, especially when dealing with multiple contaminants. The design algorithm requires powerful mathematical programming techniques and software. The Water Pinch approach uses these mathematical tools for optimization, and composite curves for graphical visualization and interpreting the results.

The Results: A Roadmap and Mutually Satisfactory New Tariffs

The scope included all manufacturing and utility facilities. A water balance for the plant identified the sources of water usage and wastewater effluent. Fairly good closure was achieved between identified water users and metered flows. The wastewater effluent flows, however, could not be completely reconciled between metered values and identified sources. Nevertheless, a mutually consistent set

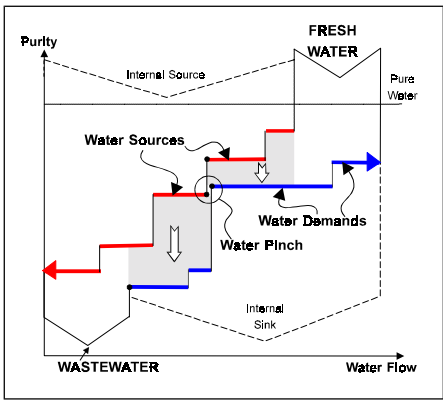

Figure 1. Water Pinch Approach: Basic Representation

of water conservation projects were developed using the Water Pinch approach.

Total savings potential was found to be 45% of the identified effluent streams. A set of 23 projects was developed that together reduced city water consumption and wastewater flow by 580 gpm (0.037 m^3/s), worth over $1.6 MM/year. The project descriptions highlighted the technical risks and set implementation priorities based on anticipated cost relative to savings for each project. The projects fell into three categories:

- Group 1: Projects with low technical risk and low capital cost (saving 285 gpm (0.018 m^3/s) of wastewater; $1039 K/yr)
- Group 2: Projects with some unresolved technical issues, and which therefore require additional investigation or study (savings = 246 gpm (0.016 m^3/s) of wastewater; $519 K/yr)
- Group 3: Promising projects believed to be worth implementing, but not as immediately as Group 1 or 2 (savings = 43 gpm (0.003 m^3/s) of wastewater; $103 K/yr)

The estimated savings in million dollars per year based on the renegotiated new tariff structure were:

	Cost, $MM/yr		Savings	
	Before	After	$MM/yr	%
City Water	1.41	1.08	0.33	23
P-Chem	2.36	1.98	0.38	16
Amer Botms (post 2001)	2.21	1.73	0.48	21
Product Recovery	0.00	-0.46	0.46	n/a
Totals	5.98	4.33	1.65	28

Dave Richardson (left) and Guy Steensgard of Solutia recognized the benefits chemical plants can realize by utilizing water pinch technology.

The Before column represents Solutia's costs under the new tariff structure before any wastewater conservation projects were implemented, and the After column represents what they would be after all conservation projects are implemented. The % cost savings do not match % flow reduction because of the non-linear structure of the effluent discharge rate schedule.

In addition, a metering program for individual plant effluent flows was recommended to quantify the sources of the missing 670 gpm (0.042 m^3/s) of effluent.

What Did It Cost

The study cost about $125,000 for consultant fees and $50,000 for the company (staff time, travel expenses), and took 6 months to complete.

The Bottom Line: Systematic Approach is Superior

This systematic approach to wastewater management is superior to the old trial and error method. Electric utilities who participate in such studies could help influence the technology decisions made by their major industrial customers, and bring them more into alignment with utility company objectives.

Company Profile

Solutia Inc. was formed as a separate company in 1997 from the chemical businesses of Monsanto. The company is organized into four business units, operating 18 manufacturing plants worldwide. The Krummrich plant produces a complete line of chlorobenzenes, muriatic acid, phosphorous pentasulfide, and water treatment chemicals.

"Pinch Analysis is a powerful methodology that we have used to solve difficult and complex wastewater management issues at our site. We have found it particularly useful for making capital investment decisions, and in developing our strategic plans."

Dave Richardson, Utilities Manager

Photograph courtesy of Solutia Inc.

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13—11, 21, 81, 89; **28**—all; **29**—all

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EPRI Chemicals, Petroleum & Natural Gas Center 47 Quiet Oak Circle • The Woodlands, TX 77381
281.419.0325 • epricpc1@ix.netcom.com

EPRI Corporate address • 3412 Hillview Avenue, Palo Alto, CA 94304 • PO Box 10412, Palo Alto, CA 94303 USA
800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com